

RIVERS AND FLOODS.

E. H. BOWIE, District Forecaster.

Floods occurred during the month in the Missouri, the Neosho, and the middle Mississippi rivers, and severe local freshets occurred in the Marais des Cygnes River in eastern Kansas and western Missouri, the Jordan River, at Springfield, Mo., and in Perry Creek, a small stream which empties into the Missouri River at Sioux City, Iowa.

The most disastrous flood, that of the Missouri River, was remarkable for the fact that the highest stages of water of previous record during the month of July were exceeded. The river was above flood stage at all places, with the exception of Plattsmouth, Nebr., from Omaha to its mouth, and at Glasgow, Mo., the crest stage of 28.9 feet, was only 0.8 foot below the high-water mark of June 5, 1903.

While considerable loss and damage was caused by the flood above Kansas City, it did not assume such serious proportions as in the central and western portions of the State of Missouri. The following detailed reports of this flood, made by the officials in charge of the Kansas City and St. Louis river districts, respectively, indicate the magnitude of the damage caused thereby.

FLOODS IN THE MISSOURI RIVER ABOVE KANSAS CITY.

By Mr. P. CONNOR, Official in charge, Local Office, Weather Bureau, Kansas City, Mo.

The flood of 1909 in this river district was strictly a Missouri River flood, the Kansas River being safely within its banks the entire season. While the great commercial interests of this city suffered comparatively little, still the flood was not devoid of interest. Public anxiety reached a high tension, as only a few more local rains were necessary to have caused a flood of great magnitude and heavy damage.

The Missouri became bank-full early in June. It remained above the flood stage at St. Joseph from June 8 to July 23, reaching its maximum at that place on July 11. At Kansas City it was close to flood stage from June 17 to 30, inclusive, then began to rise slowly until July 13 when a crest of 27 feet, was reached, after which followed a slow, steady fall until July 20 when the river was again within its banks.

This flood was given its initial start by a combination of snow and rain waters from the upper Missouri Valley in June, which left but a small margin of channel to take care of the early summer rains in the middle and lower sections, which, during the first decade of July became decidedly erratic, a 4-inch measurement in less than twenty-four hours being not at all uncommon.

The flood was made up of two distinct waves. The first crest arrived on the evening of July 8 and remained stationary until the night of the 9th. A fresh outburst of rains then caused the river to rise two feet higher, with a crest on the morning of the 13th of 27 feet.

Anticipating these conditions, the statement was published several times in the late spring that the Missouri River would be a full stream in early summer, with conditions generally favorable for a flood, the extent of which would depend upon the character of the rains. Owing to this uncertainty, some enterprises about to be started in the bottoms were deferred until later in the year.

On June 16 warning was issued that the Missouri would reach flood stage at Kansas City on the 18th, which it did before noon of that date. Subsequent daily statements based upon periodical rains throughout this section, accurately forecast thirty-six hours in advance the additional changes that took place. On Sunday afternoon (11th) the statement was given the press and public that the maximum height of 27 feet would be reached Tuesday morning (13th), and at 7 a.m. of that date the stage was precisely 27 feet.

There was practically no damage sustained by the business

concerns of this city on account of the flood, except the cost of removing goods to higher floors or other places of safety, pumping out basements, replacing merchandise, and a slight loss due to the interruption of business because of the inadequacy of railroad transportation. It is reported that only two or three basements in the west bottoms did not have water in them. There was water in the stockyards for several days, and it went over the streets and railroad tracks of Morris & Co's packing plant. The other packing houses have protected themselves with concrete walls. Armourdale, the southern portion of Kansas City, Kans., was protected by a dike which had been built since the flood of 1908. Harlem, directly north of Kansas City, Mo., on the north bank of the Missouri, was flooded, but the people moved their goods to places of safety, so that moving expenses covered their losses. The total damage by the flood in this immediate vicinity probably did not exceed \$250,000.

The heavy loss this year fell upon those interested in bottom lands. About 20,000 acres of bottom land from a little above St. Joseph to Kansas City were overflowed. Seventy per cent of that area was devoted to wheat and corn, the remainder being pasture. About 80 per cent of the crops were lost.

Railroads centering in this city met with heavy losses by reason of roadbeds having been washed out by heavy rains in western Missouri and eastern Kansas. Train service was demoralized for several days.

THE FLOODS FROM KANSAS CITY TO ST. LOUIS, MO.

By O. C. BURROWS, Observer, Local Office, Weather Bureau, St. Louis, Mo.

At the beginning of July the Missouri was bank-full between Kansas City and Boonville. During the period from June 29 to July 8, inclusive, heavy rains fell in southeastern Nebraska, northeastern Kansas, southern Iowa, and western and northern Missouri, ranging in amounts from 6 to 12 inches. These rains caused rapid rises in all streams in the affected district, many streams becoming raging torrents, particularly the Grand River in northwestern Missouri, which reached the highest stage of recent years. Much of this flood water found its way to the Missouri and caused it to rise rapidly. It passed the flood stage at Glasgow on the 6th, Boonville on the 7th, and Hermann on the 9th. The river continued to rise rapidly for several days and reached the crest stage of 28.9 feet at Glasgow on the 11th, 28.3 feet at Boonville on the 13th, and 26.1 feet at Hermann on the 14th. Back water from the Mississippi caused the Mississippi to rise to within 0.4 foot of the flood stage at Grafton and to above the flood stage at Alton. The Mississippi rose steadily below the mouth of the Missouri, passed the flood stage at St. Louis on the 11th and reached the crest stage of 35.5 feet on the evening of the 16th. The Missouri was above the flood stage at Glasgow and Boonville for 15 days and at Hermann for 10 days, while the Mississippi was above the flood stage at St. Louis for 11 days. The crest stages at Glasgow, Boonville, Hermann, and St. Louis were the highest reached since the flood of June, 1903, and except at St. Louis, were the highest of record for the month of July.

As is usual in such floods, an immense amount of property was destroyed. This was especially true in northwestern Missouri where railroad traffic was at a standstill for several days, as tracks were under water or washed away, and bridges washed out. The loss to the railroads, from suspension of business and damage to roadbeds and bridges, amounted to many thousands of dollars, but actual figures are not at hand and it will be some time before they are available.

Along the Missouri and Grand rivers it is estimated that about 700,000 acres, 400,000 acres of which were under cultivation, were inundated. There are no levees of importance

along these streams. Since the flood of 1903, the levee system on the Illinois side of the Mississippi River between Alton and Chester, Ill., protecting what is known as the Americans Bottoms, has been raised and strengthened. This afforded protection to much valuable land that would otherwise have been inundated as most of the levees in this system withstood the flood. The system, however, is still inadequate and a great deal of land in this district was submerged. It is estimated that about 300,000 acres of rich farm land were flooded between Hannibal and Chester. More than half of this district was under cultivation. The water extended back 8 or 10 miles to the bluffs in portions of the American Bottoms below St. Louis where there are no levees of importance. The total area submerged along the Missouri and its tributaries below Kansas City and along the Mississippi between Hannibal and Chester was approximately 1,000,000 acres, and more than half of this land was under cultivation. A number of towns and villages in this district were wholly or partially inundated, namely, Gault, Pattonsburg, Trenton, Gallatin, Barnard, Avenue City, Maryville, Chillicothe, and Cedar City, Mo., and East Alton, Venice, and Brooklyn, Ill. The overflowed district in St. Louis embraced some low bottom land in the northern portion of the city which is used as railroad yards, and Front street. The levees that protect East St. Louis, Granite City, and Madison, all held and no portion of these cities was under water. The loss in St. Louis, East St. Louis, Madison, and Granite City, was confined almost entirely to a suspension of business and to the expense necessitated by the removal of merchandise, and was, therefore, nominal.

It is estimated that the loss of, and damage to, property, including railroads, live stock, farm buildings, and farm machinery, for the entire district, amounted to about \$700,000, and that the value of crops destroyed was about \$5,500,000. The loss would have been greater had it not been for timely warnings issued by the Weather Bureau. These warnings were given wide dissemination through the press and by telegraph and afforded farmers an opportunity to save an immense amount of wheat which was ready to be harvested, and to remove portable property to places of safety. Corn and miscellaneous crops were a total loss in the affected district as the flood occurred so late in the summer that it will not be possible to replant any of the crops. It is roughly estimated that the warnings of the Weather Bureau were instrumental in saving property valued at \$1,000,000. Farm land was probably damaged \$100,000 by erosion and deposit, and the loss by suspension of business and for the protection of property was probably \$150,000. As far as known, only four lives were lost.

The loss and damage resulting from the flood in the Missouri River is estimated at \$7,000,000, and the value of property saved by the flood warnings of the Weather Bureau at considerably more than \$1,000,000.

The flood in the upper Neosho River, July 11 to 15, inclusive, caused considerable damage, but owing to the efficient flood warning service in that vicinity, property to the amount of about \$150,000 was saved. The unavoidable losses on the upper Neosho were as follows:

Loss and damage to property, including railroads and excluding crops	\$250,000
Loss and damage to crops	735,000
Damage to farm lands by erosion	5,000
Loss through enforced suspension of business, etc...	9,000
Total	999,000

Warnings were promptly issued and well disseminated in ample time for precautions to be taken.

Unseasonably high water also prevailed during the month in the Mississippi River from below Keokuk, Iowa, to the mouth of the Missouri River. The river was above the flood stage at Hannibal, Mo., from the 7th to the 13th, inclusive, and damage to crops between Hannibal, Mo., and Quincy, Ill., to the extent of about \$75,000 resulted. Other losses were of minor importance. Property to the value of probably \$2,000 was saved by the flood warnings of the Weather Bureau.

Exceptionally high water for the month of July also prevailed at Cairo, Ill., but the river did not reach flood stage, and no losses of importance resulted.

At Memphis, Tenn., conditions were much the same as at Cairo, Ill., although the river rose to slightly above the flood stage and remained so from the 21st to the 26th, inclusive. The rise at Memphis is remarkable for the fact that it reached the highest stage ever recorded in July, and with one exception, the highest on record for any month later than May. The previous highest stage for July was 31.5 feet in 1875, in which year the river also reached a stage of 33 feet in August. The condition of the ground in regard to dryness, low-water supply in the swamps and small streams, and evaporation played an important part in restraining the rise, or much higher stages would have been reached.

The flood which swept the valley of the Marais des Cygnes River in eastern Kansas and western Missouri during the early part of July did considerable damage to crops, but an estimate of the amount of loss is not available.

A severe local freshet occurred at Springfield, Mo., on July 7 and 8, in the Jordan River, a small stream that flows through that city. Excessive rains on the 7th and 8th, over Greene and Christian counties, caused that comparatively insignificant stream to become a raging torrent, and the resulting damage amounted to between \$400,000 and \$500,000. The greatest losses were sustained by farmers, railroad companies, wholesale firms, and the Springfield Water Works Company.

Another local freshet, somewhat similar to that at Springfield, Mo., occurred at Sioux City, Iowa, on July 9 to 12, caused by heavy rains over the watershed of Perry Creek, a small stream that flows into the Missouri River at Sioux City.

Hydrographs for typical points on seven rivers are shown on Chart I. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport on the Red.

SPECIAL PAPERS ON GENERAL METEOROLOGY.

RECENT PAPERS BEARING ON METEOROLOGY AND SEISMOLOGY.

C. FITZHUGH TALMAN, Librarian.

The subjoined titles have been selected from the contents of the periodicals and serials recently received in the Library of the Weather Bureau. The titles selected are of papers or other communications bearing on meteorology or cognate branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled;

it shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau. Unsigned articles are indicated by a —.

American philosophical society. Proceedings. Philadelphia. v. 48. May-June, 1909:

Hovey, Edmund Otis. Earthquakes: their causes and effects. p. 235-258.

Hobbs, William Herbert. The evolution and outlook of seismic geology. p. 259-302.

Reid, Harry Fielding. Seismological notes. p. 303-312.